COST AND PERFORMANCE REPORT

Vacuum-Enhanced, Low-Temperature Thermal Desorption
at the Rocky Flats Environmental Technology Site
Golden, Colorado

November 1999

EPA
U.S. Environmental Protection Agency
Office of Solid Waste and Emergency Response
Technology Innovation Office

SITE INFORMATION

Identifying Information:

Rocky Flats Environmental Technology Site (Rocky Flats), Trenches T-3 and T-4, Golden, Colorado

CERCLIS # CO7890010526

Action Memorandum Date:
January 18, 1996

Treatment Application:

Type of Action: Removal

EPA SITE Program Test Associated With Application? No

Period of Operation: June - August 1996

Quantity of Material Treated During Application: 3,796 cubic yards of soil and debris

Background

Waste Management Practice That Contributed to Contamination: Burial of drums and debris in trenches on the site.

Site History [1,3,4,5]: From 1951 to 1989, the U.S. Department of Energy (DOE) used the Rocky Flats site to process and store plutonium, manufacture components for nuclear weapons, fabricate, machine, and assemble components from metals, and store solvents used in the manufacturing processes. Hazardous and radioactive wastes were stored and disposed of at various locations at the site, including on-site trenches. Waste handling practices at the site also included recycling of hazardous materials.

Trenches T-3 and T-4, shown in Figure 1, were used for the disposal of sanitary sewage sludge contaminated with uranium and plutonium and miscellaneous debris, primarily flattened drums contaminated with volatile organic compounds (VOCs), uranium, and plutonium. Trench T-3 was used from 1964 to 1966 and trench T-4 was used from 1966 to 1967.

Preliminary site assessments, conducted by DOE in March 1987 during a Phase I Remedial Investigation under the Environmental Restoration Program (formerly known as the Comprehensive Environmental Assessment and Response Program), identified several of the on-site storage and disposal locations as potential sources of contamination. Further investigations by DOE showed that soil, sediment, groundwater and surface water at the site were contaminated with VOCs, metals, and radionuclides. Subsurface soils in trenches T-3 and T-4 were found to contain elevated levels of VOCs, semivolatile organic compounds, and metals, along with low-level radiological contamination.

In 1989, the Federal Bureau of Investigation (FBI) and the Environmental Protection Agency (EPA) shut down operations at Rocky Flats due to violations of environmental statutes.

Regulatory Context [1,5,11]: The contamination at the Rocky Flats site is being addressed through a number of Records of Decision (RODs) and Interim Measures/Interim Remedial Actions (IM/IRA). In September 1992, an IM/IRA was issued to address VOC contamination in three subsurface areas of operable unit (OU) 2, which included the T-3 and T-4 trenches. The IM/IRA indicated that pilot-scale testing of soil vapor extraction (SVE) was to be conducted in each subsurface area.

Pilot-scale SVE testing was conducted in the T-3/T-4 trench area. An evaluation of the results of the pilot study indicated that SVE was not effective on the T-3/T-4 soils because the soils were “packed too tightly”. A Proposed Action Memorandum (PAM) was issued in January 1996 calling for thermal treatment of the T3/T4 soils based on the results of the SVE pilot test and negotiations of a new Rocky Flats Cleanup Agreement that called for “more aggressive” remediation at the site. The PAM was approved by DOE, EPA, and the Colorado Department of Public Health and Environment (CDPHE).

Figure 1. Site Map [6]

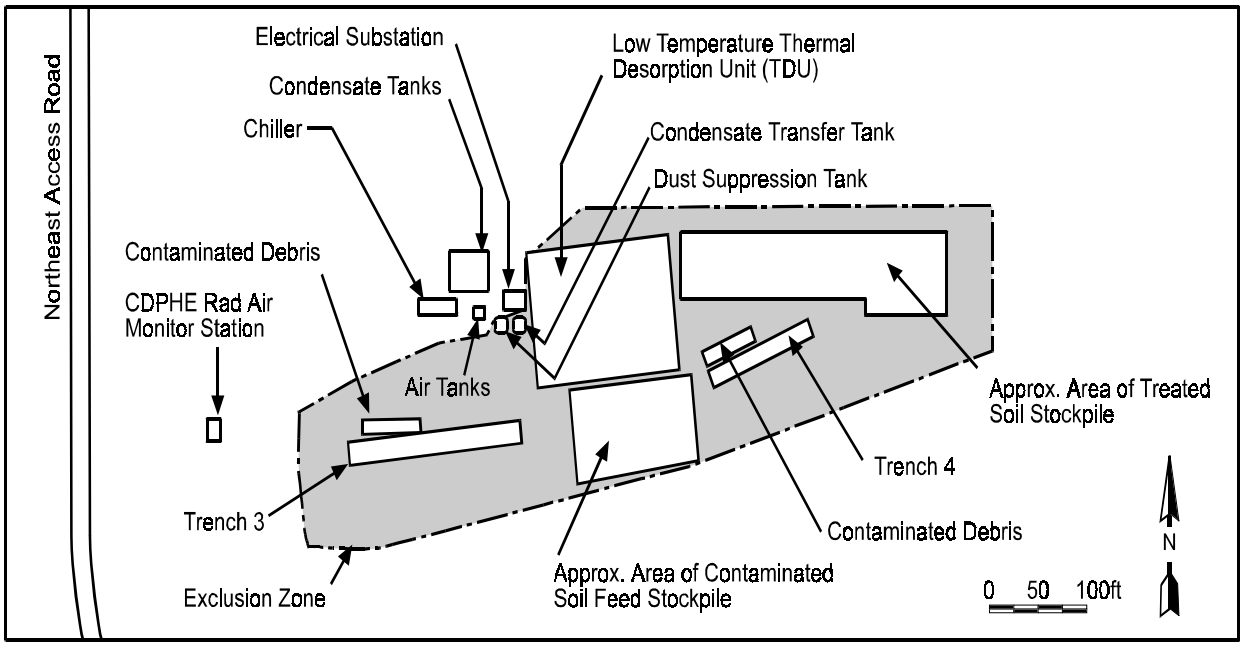
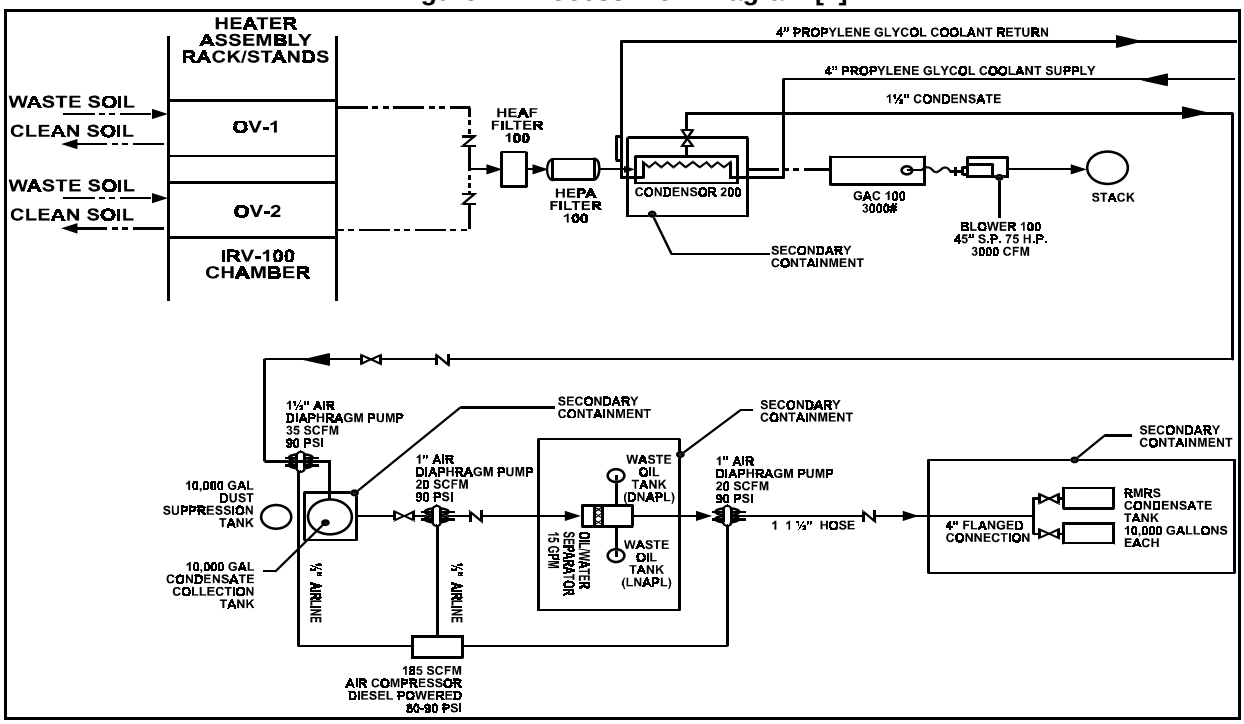


Figure 2. Process Flow Diagram [7]



SITE INFORMATION (CONT.)

Remedy Selection: On-site thermal desorption

Site Logistics/Contacts [2]

Site Management: DOE

Oversight: EPA and CDPHE

EPA:

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Rocky Flats Project Coordinator
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DOE Contact:

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Rocky Mountain Remediation Services, LLC
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Treatment System Vendor:

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*Primary contacts for this application.

MATRIX DESCRIPTION

Identification

Type of Matrix: Soil and debris (ex situ)

Contaminant Characterization [5]

Primary Contaminant Groups: VOCs

The primary contaminants of concern for the T-3 and T-4 trenches were VOCs, including trichloroethene (TCE), tetrachloroethene (PCE), 1,1,1-trichloroethane (TCA), methylene chloride, and carbon tetrachloride. Tables 1 and 2 present the results of analyses from subsurface soil samples for the T-3 and T-4 trenches, collected in November 1994 and the Spring of 1995, respectively. The highest concentrations of VOCs in trench T-3 were TCA at 13,000 mg/kg, acetone at 5,100 mg/kg, methylene chloride at 2,400 mg/kg, and carbon tetrachloride at 700 mg/kg. The highest concentrations of VOCs in trench T-4 were TCE at 680 mg/kg and acetone at 120 mg/kg.

In addition, the subsurface soils were contaminated with metals such as barium, lead, and manganese, and low levels of radionuclides, including uranium, plutonium, and tritium.

Matrix Characteristics Affecting Treatment Costs or Performance [2]

Table 3 presents the major matrix characteristics that affected the cost or performance of this technology and the values measured for each.

Table 3: Matrix Characteristics

Parameter	Value
Soil classification	Calcareous sandy gravel and clayey gravel (Rocky Flats Alluvium)
Moisture content	Approximately 8 percent
Particle size distribution	Not available
Oil and grease	Not available
Bulk density	Not available

MATRIX DESCRIPTION (CONT.)

Table 1: VOCs in Trench T-3 Subsurface Soil (November 1994) [5]

Contaminant	No. of Samples	No. of Detections*	Percent Detections	Range of Concentrations (mg/kg)
1,1,1-Trichloroethane	22	8	36.4	0.006-27[J]
Acetone	21	8	38.1	0.036-5,100[B]
Carbon tetrachloride	22	10	45.5	0.004[J]-700
Chloroform	22	6	27.3	0.001[J]-8.8
Ethylbenzene	22	1	4.5	0.009
Methylene chloride	22	16	72.7	0.003[J]-2,400[B]
Tetrachloroethene	22	20	90.9	0.002[J]-13,000[D]
Toluene	22	13	59.1	0.022-7.6[J]
Trichloroethene	22	5	22.7	0.002[J]-120

[J] Estimated result
[D] Dilution result
[B] Contaminant was detected in blank sample

Table 2: VOCs in Trench T-4 Subsurface Soil (Spring 1995) [5]

Contaminant	No. of Samples	No. of Detections*	Percent Detections	Range of Concentrations (mg/kg)
1,1,1-Trichloroethane	18	4	22.2	0.002[J] -2.3[J]
1,1-Dichloroethene	18	1	5.6	0.009
Acetone	18	3	16.7	0.026[J]-120
Carbon tetrachloride	18	1	5.6	0.35[J]
Chloroform	18	2	11.1	0.004[J]-0.77[J]
Ethylbenzene	18	3	16.7	0.012-0.87[D,J]
Methylene chloride	18	3	16.7	0.19[B,J]-8.2[B,J]
Tetrachloroethene	18	11	61.1	0.001[J]-37
Toluene	18	10	55.6	0.003[J]-0.67[J]
Trichloroethene	18	8	44.4	0.02[J]-680

[J] Estimated result
[D] Dilution result
[B] Contaminant was detected in blank sample

DESCRIPTION OF THE TREATMENT SYSTEM

Primary Treatment Technology

Vacuum-enhanced low temperature thermal desorption

Supplemental Treatment Technology Types:

Post-Treatment (Air): Dry particulate filter (DPF), condenser and chiller, activated carbon

Post-Treatment (Water): Oil/water separator

System Description and Operation [2]

The thermal desorber used at this site, an infrared radiation-heated unit manufactured by McLaren-Hart (the IRV-100 system), was a modular, batch-operated vacuum system. Prior to full-scale operation, McLaren-Hart conducted a required demonstration using approximately 500 cubic yards of contaminated soil. Authorization to commence full-scale treatment operations was received in June 1996. The full-scale system used six IRV-100 treatment chambers with associated support and emissions control equipment. Figure 2 shows a process flow diagram for the system.

The treatment chamber within each unit was a rectangular bed of carbon steel that measured approximately 18 feet long, 8 feet wide and 5 feet high, and had a total operating capacity of approximately five cubic yards (yd^3). The contaminated material was placed on top of a layer of pea gravel in the treatment chambers to a depth of approximately 12 inches, and raked smooth for uniform heating and air flow. A hinged access gate, which folded downward to facilitate loading, was closed and locked in place. Treatment chamber design parameters are shown in Table 4.

Infrared radiation from inconal metal screens heated by propane gas was used to generate the thermal energy necessary to desorb the target contaminants. The system was equipped with sixteen propane units with a total system output of approximately one and one-half million British Thermal Units per hour (BTU/Hr) for each chamber.

Table 4: Treatment Chamber Design Parameters [2]

Parameter	Specification
Unit Footprint Requirements	20 feet x 30 feet (per unit set-up)
Treatment Chamber Capacity	Approximately 5 cubic yards
Unit size	18 feet x 8 feet x 5 feet
Unit Weight	9,000 pounds
Fuel Requirements	Propane / butane / natural gas
Filter Media	3/8 inch pea gravel
Heat Transfer Method	Radiant (infrared energy, convective and conductive)
Power Requirements	480 volt, 3 phase, 100 amps (two units)

Generally, the infrared radiation heated the surface of the soil to over 250°F within 30 minutes. The remaining volume of soil was then heated by conductive and convective heat transfer.

The system was operated under a vacuum of approximately 500 millimeters of mercury (mm Hg). Air was evacuated from the treatment chamber through nine 4-inch diameter, 0.1-inch slotted, well screens which are located on the bottom of the treatment chamber. The outlets of each pipe were manifolded together to produce one exhaust pipe. In order to maintain the vacuum conditions at a steady state, atmospheric air was allowed into the treatment chamber through the top of the unit. The flow of air was controlled by gate valves and monitored with in-line flow meters. One vacuum blower was used to service two treatment chambers.

Two dry particulate filters (DPFs, in series), a condenser, and a granular activated carbon (GAC) unit were used to control emissions from the system. The DPFs were in-line, static microfiltration elements (>5 microns) that were

DESCRIPTION OF THE TREATMENT SYSTEM (CONT.)

used to minimize particulate accumulation in downstream air emission control components and to control the release of smoke and particulates to the atmosphere.

The condenser was used to reduce air stream temperatures to less than 50°F, and to remove the majority of entrained water and desorbed contaminants. Condensate was collected in a tank and treated using an inclined plate oil/water separator. The aqueous phase was then transferred to two 10,000-gallon storage tanks prior to undergoing on-site treatment at a Resource Conservation and Recovery Act (RCRA) permitted wastewater treatment facility. In total, over 330,000 gallons of condensate (water and contaminants) were collected and treated at the site, resulting in the generation of 33 drums of organic waste in the form of dense nonaqueous phase liquids (DNAPLs).

The GAC unit was used as a polishing step for the vapors prior to release to the atmosphere. Approximately 10,000 pounds of waste vapor phase carbon were generated in this application.

Thermal treatment operations were conducted from June to August, 1996. The system was operated on a continuous-shift basis (24 hours/day, 5 days/week). The average treatment rate for the system was five cubic yards per hour. In general, the average treatment cycle time excluding implementation of radiological engineering controls was approximately 5.25 hours/treatment chamber.

Baseline operating conditions, including soil temperature and treatment time, were established during initial startup operations (also referred to as the performance demonstration period). During this timeframe, process verification samples were collected and analyzed from each of the six treatment chambers and the results used to modify the operating parameters until baseline conditions could be established such that the soil treatment goals were met on the first pass through the unit. Once baseline conditions were established, the sampling frequency was decreased to one sample per batch (about 30 cubic yards).

Prior to treatment, each load of excavated soil was screened using a Field Instrument for the Detection of Low Energy Radiation (FIDLER) to identify "potentially radiologically contaminated material". Soil with readings above 5,000 counts per minute (cpm) were segregated and treated separately from the soil that was not considered to be potentially radioactive. A total of about 380 cubic yards of soil were identified as potentially radioactive.

Oversize material that could not be treated in the thermal desorber, such as drums, wood, and concrete blocks, were shipped off-site for disposal.

Operating Parameters Affecting Treatment Cost or Performance

Table 5 presents the major operating parameters that affected cost or performance of the technology and the values measured for each.

Table 5: Operating Parameters Per Treatment Chamber [2]

Parameter	Value
Vacuum condition in treatment chamber	Approximately 500 mm Hg
Energy output of total system (infrared energy)	1.5 MM Btu/hr
Air flow rate	1,000-3,000 cfm
Total cooling capacity of chiller	450°F
Residence time	Approximately 5.25 hours
System throughput	Approximately 1 yd^3/hour
Soil temperature	250°F

DESCRIPTION OF THE TREATMENT SYSTEM (CONT.)

Timeline [2, 3, 4]

Start/End Date	Activity
1951-1989	DOE operated Rocky Flats as a manufacturing and storage facility for nuclear weapons components.
March 1987	Phase I Remedial Investigation begun at Rocky Flats.
September 1, 1992	ROD for Trenches T-3 and T-4 issued.
September 10, 1992	IM/IRA/EA issued by DOE to identify and evaluate interim remedial actions.
January 18, 1996	Proposed Action Memorandum for Trenches T-3 and T-4 issued.
April 1996	Rocky Mountain Remediation Services awarded T3/T4 Contract to McLaren-Hart, Inc.
May 1996	Site mobilization initiated.
June 1996	Treatment system operation begun at trenches T-3 and T-4.
July 3, 1996	Excavation of Trench T-3 completed.
July 11, 1996	Treatment of Trench T-3 soil completed.
August 14, 1996	Excavation of Trench T-4 completed.
August 19, 1996	Treatment of Trench T-4 soil completed.
August 1996	Treatment system shut down; demobilization of site initiated.
September 6, 1996	Demobilization of site completed.

TREATMENT SYSTEM PERFORMANCE

Cleanup Goals/Standards [2, 5,11]

Table 6 presents the cleanup goals for the T-3 and T-4 soils treated by thermal desorption. The cleanup goals were specified in the PAM for the 12 VOCs of concern and are the universal treatment standards (40 CFR Part 268) for those contaminants.

Air emissions standards for the thermal desorption system were identified in the PAM as the applicable or relevant and appropriate requirements (ARARs). These included the Colorado Air Pollution Prevention and Control Act standards 5 CCR 1001-3 and 1001-9 for particulates and VOCs, 5CCR 1001-14 for the National Ambient Air Quality Standards (NAAQS), 6 CCR 1007-3, 264 Subpart AA and Subpart BB for process air emissions, and 264 Subpart X for hazardous waste operations. As a result of the radionuclides present in the trenches, radiation exposure guidelines contained in DOE Order 5400-5, Chapter 2.1a, 1b, and Chapter 3 were required to be followed to ensure protection of site personnel.

During the initial startup phase, three stack air monitoring tests were performed to verify the efficiency of the emission control system and the adequacy of the emission monitoring method for the targeted VOCs. During full-scale operations, exhaust stack emissions (after the carbon system) were monitored on a continuous basis for total organic compounds using a Flame Ionization Detector (FID).

TREATMENT SYSTEM PERFORMANCE (CONT.)

Performance Data [2,3,12,13]

A total of 58 batches (3,796 yd^3 total) of soil were treated during this application. Treated soils samples were collected from each batch and analyzed for the 12 VOCs of concern.

During the shakedown period used to establish operating conditions, samples from each batch were collected from all six treatment chambers. Once the baseline conditions were established, the number of treatment chambers sampled per batch decreased, ranging from one to five chambers. A total of approximately 220 samples were analyzed for this application.

The results of the analyses of treated soil are summarized in Table 6. Of the 58 batches treated, 52 met the cleanup goals on the first pass, including 20 batches where all 12 VOCs were below the detection level. Six batches (#3, #5, #6, #7, # 24, and # 27) did not meet the cleanup goals on the first pass, exceeding the level for PCE. These batches were retreated and met the cleanup goals.

Concentrations of six VOCs (TCA, DCE, DCA, carbon tetrachloride, chloroform, and ethylbenzene) were below the detection level in all 58 batches.

Stack emissions (after the carbon polishing system) were continuously monitored for total organic compounds using EPA Method 25A (flame ionization detector). According to the vendor, there were no exceedances of the applicable air emissions standards.

Performance Data Quality [2]

According to the vendor, the QA/QC program used throughout the remedial action met EPA, DOE, and CDPHE requirements. All monitoring was performed using EPA-approved methods. Results of all laboratory analyses were submitted with a Level III data quality package and are on file with DOE. No exceptions to QA/QC protocols were noted by the vendor for this application.

COST OF THE TREATMENT SYSTEM

Procurement Process [2,8]

McLaren-Hart was issued a lump sum contract for $1,200,000 in April 1996 for the remediation of 2,200 yds^3 of contaminated soil from the T-3 and T-4 trenches. Rocky Mountain Remediation Services, L.L.C. (RMRS) contracted with McLaren-Hart for this project. RMRS was the Environmental Restoration Program subcontractor to Kaiser-Hill (the DOE prime contractor).

Costs [2,8,9,10]

Table 7 presents the actual cost data for the thermal desorption application for contaminated soil from Trenches T-3 and T-4. Cost data were provided by McLaren-Hart. All costs for investigation, construction, and remediation at Trenches T-3 and T-4 were borne by DOE under the Environmental Restoration Program.

The total cost for this project was $1,934,203, including $1,328,600 in costs directly associated with the thermal treatment. The calculated unit cost was $350/$yd^3$ based on the treatment of the 3,796 yd^3 of contaminated soil and debris. The actual cost does not include excavation and disposal of residuals.

The original contract cost was $1,200,000, based on treating 2,200 yds^3 of contaminated soil. Two change orders were issued for the remediation of additional soil volumes, changing the total amount of soil treated from 2,200 yd^3 to 3,796 yd^3, with a final project cost of $1,934,204.

Table 6: Summary of Treated Soil from Trenches T-3 and T-4 [12]

Batch #	Treated Soil Concentrations for Constituents of Concern (mg/kg) (Clean Up Goal - mg/kg)											
	TCA (6)	DCE (6)	DCA (6)	Benzene (10)	Acetone (160)	Carbon Tetra-chloride (6)	Chloro-form (6)	Ethyl-benzene (10)	Methylene Chloride (30)	PCE (6)	Toluene (10)	TCE (6)
1-2, 11, 13, 19-22, 26, 28, 29, 35, 36, 40,41,43,44, 46,47,58	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-**14**	ND	ND-1.3
4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-5.1	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-**10**	ND	ND-1
6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-**10**	ND	ND-0.76
7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-**26**	ND	ND
8	ND	ND	ND	ND	ND-1.7	ND	ND	ND	ND	ND-1.9	ND	ND
9	ND	ND	ND	ND	ND-5.5	ND	ND	ND	ND	ND-0.78	ND	ND
10	ND	ND	ND	ND	ND-5.5	ND	ND	ND	ND	ND-1.4	ND	ND
12	ND	ND	ND	ND	ND-5.5	ND	ND	ND	ND	ND-2.6	ND	ND
14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-1.6	ND	ND
15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-2	ND	ND
16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-2.6	ND	ND
17	ND	ND	ND	ND-0.01	ND-0.06	ND	ND	ND	ND-0.03	ND-1.2	ND	ND
18	ND	ND	ND	ND	ND-1.8	ND	ND	ND	ND	ND-0.78	ND	ND
23	ND	ND	ND	ND	ND-3.5	ND	ND	ND	ND	ND	ND	ND
24	ND	ND	ND	ND	ND-5.1	ND	ND	ND	ND	ND-**7.7**	ND	ND
25	ND	ND	ND	ND	ND-3.3	ND	ND	ND	ND	ND	ND	ND
27	ND	ND	ND	ND	ND-2.7	ND	ND	ND	ND	ND-**9.3**	ND	ND
30	ND	ND	ND	ND	ND-1.4	ND	ND	ND	ND	ND	ND	ND
31	ND	ND	ND	ND	ND-1.4	ND	ND	ND	ND	ND	ND	ND
32	ND	ND	ND	ND	ND-1.7	ND	ND	ND	ND	ND	ND	ND
33	ND	ND	ND	ND	ND-2.1	ND	ND	ND	ND	ND	ND	ND
34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND-0.71	ND	ND

Table 6: Summary of Treated Soil from Trenches T-3 and T-4 [12] (continued)

Batch #	Treated Soil Concentrations for Constituents of Concern (mg/kg) (Clean Up Goal - mg/kg)											
	TCA (6)	DCE (6)	DCA (6)	Benzene (10)	Acetone (160)	Carbon Tetra-chloride (6)	Chloro-form (6)	Ethyl-benzene (10)	Methylene Chloride (30)	PCE (6)	Toluene (10)	TCE (6)
37	ND	ND	ND	ND	ND-1.9	ND	ND	ND	ND	ND-0.02	ND	ND
38	ND	ND	ND	ND	ND-6	ND	ND	ND	ND-0.01	ND	ND	ND
39	ND	ND	ND	ND	ND-5.6	ND	ND	ND	ND	ND-3.7	ND	ND
42	ND	ND	ND	ND-0.01	ND-3.6	ND	ND	ND	ND	ND-0.63	ND	ND
45	ND	ND	ND	ND-0.31	ND-6.5	ND	ND	ND	ND	ND-0.02	ND-0.01	ND
48	ND	ND	ND	ND	ND-2.3	ND	ND	ND	ND	ND-1.7	ND	ND
49	ND	ND	ND	ND	ND-3.7	ND	ND	ND	ND	ND	ND	ND
50	ND	ND	ND	ND	ND-4.3	ND	ND	ND	ND	ND	ND	ND
51	ND	ND	ND	ND	ND-5.2	ND	ND	ND	ND	ND	ND	ND
52	ND	ND	ND	ND	ND-2	ND	ND	ND	ND	ND	ND	ND
53	ND	ND	ND	ND-9.3	ND-3.4	ND	ND	ND	ND	ND	ND	ND
53	ND	ND	ND	ND	ND-2.6	ND	ND	ND	ND	ND	ND	ND
55	ND	ND	ND	ND	ND-6.7	ND	ND	ND	ND	ND	ND	ND
56	ND	ND	ND	ND	ND-2.2	ND	ND	ND	ND	ND	ND	ND
57	ND	ND	ND	ND	ND-2	ND	ND	ND	ND	ND	ND	ND

ND - Detected below the quantification limit
Bold - Numbers in bold were above the clean up goal

COST OF THE TREATMENT SYSTEM (CONT.)

Table 7: Technology Costs [2,8,9,10]

Cost Element	Cost (1996 $)
Capital Costs for Technology	
Treatment of contaminated soil and debris	$1,328,600
Other Project Costs	
Electrical and mechanical plan	
Health and safety plan	
Mobilization and demobilization	
Post-process sampling	
Waste characterization sampling	
Standby	
Additional items:	
Industrial hygiene and health physicist support for radiological monitoring, radiological workers' training, DOE Operational Readiness Review, and implementation of radiological engineering (emission) controls	$605,604
Total Project Cost	$1,934,204
Total Cost for Calculating Unit Cost	$1,328,600
Quantity Treated	3,796 yd^3
Unit Cost	**$350/$yd^3$**

OBSERVATIONS AND LESSONS LEARNED

Cost Observations and Lessons Learned [2,3,8,10]

The total project cost at Rocky Flats was approximately $1.9 million, including $1.3 million for thermal desorption and $0.6 million for other project costs, including activities associated with providing radiological emission controls. The $1.3 million for treatment corresponds to $350 per cubic yard of soil and debris treated, based on 3,726 yds^3.

According to McLaren-Hart, the total project cost would likely be less for a similar application at sites where radiological engineering controls were not required. For example, heat stress and quality assurance/quality control (QA/QC) activities required to be in compliance with DOE Order 5700.6C increased the cost of the project.

In addition, RMRS identified a problem with the use of HEAF and HEPA filters with the system. The filters were included to protect downstream equipment from radioactive contamination. However, during operation, the filter media occasionally became wet from excess water used for dust control, decreasing the filtration efficiency from 99.7 to 90 percent. As a result, radioactive contamination was introduced into the condensers and the GAC system, making incineration of the spent GAC media infeasible and increasing the overall disposal costs for the project. Potential solutions to the problem include mist eliminators inserted upstream, metal filters that could operate under wet conditions, and removal of dust control water.

OBSERVATIONS AND LESSONS LEARNED (CONT.)

RMRS identified the following as reducing costs for the project:

– costs for maintenance of filter screens was cut by 95% with no pea gravel filter media required

- use of a fixed unit price subcontract, which included a clause that allowed the unit cost to be renegotiated if the estimated quantities varied more than 15 percent from the actual quantity (this provided a lower risk to the subcontractor by removal of contingency from the bid price)

- integration of union labor forces and subcontracted personnel and services

- use of an on-site laboratory, which reduced downtime

Performance Observations and Lessons Learned [3]

The McLaren-Hart IRV-100 thermal desorption system treated 3,796 yds^3 of soil contaminated with VOCs to below cleanup levels within a three month period. Of the 58 batches of soil treated, 52 met the cleanup goals after one pass. Six of the batches did not meet the goal for PCE on the first pass and were retreated.

Other Observations and Lessons Learned [2,3]

RMRS identified replacement of filters as a problem. Sometimes filters would become clogged quickly and this would slow down production time for the system. According to the vendor, this problem could be alleviated through the addition of parallel filters, duct valves to route process air to new filters, or more accessible monitoring of filter pressure.

REFERENCES

1. EPA, DOE, and CDPHE. 1992. *Interim Measures/Interim Remedial Action Plan/ Environmental Assessment, Rocky Flats Plant (USDOE), Operable Unit 2.* September 1.

2. McLaren-Hart, Inc. Not Dated. *Cost and Performance Report: Low-Temperature Thermal Desorption of VOC-Impacted Soil at the Rocky Flats Superfund Site, Denver, Colorado.*

3. McLaren-Hart, Inc. 1998. Facsimile Transmission from Ron Hill, McLaren-Hart, Inc., to Richard Weisman, Tetra Tech EM Inc. Trenches T-3 and T-4 Source Removal Project Info. July 1.

4. EPA Region 8. 1998. Rocky Flats Plant (DOE) Fact Sheet. Internet document summarizing the history and cleanup of the Rocky Flats Environmental Technology Site. March. <http:\\ww.epa.gov/region 08/html/>.

5. U.S. DOE. 1998. Proposed Action Memorandum for the Source Removal at Trenches T-3 and T-4, IHSSs 110 and 111.1. Revision 1. January 18.

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Acknowledgments

This case study was prepared for the U.S. Environmental Protection Agency's Office of Solid Waste and Emergency Response, Technology Innovation Office. Assistance was provided by Tetra Tech EM Inc. under EPA Contract No. 68-W-99-003.